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GROWTH, FLOWERING, FRUIT SETTING AND MATURITY BEHAVIOUR OF CORIANDER (*CORIANDRUM SATIVUM* L.) WITH ORGANICS INCLUDING BIOFERTILIZERS AND INORGANICS

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ABSTRACT
A field experiment was conducted during 2008-09 and 2009-10 to study the effect of different bio-fertilizers namely PSB, Nitrate fixers and KM along with Vermicompost (2 tha^{-1}), NPK (30:30:15 kg ha^{-1}) and organic manures (cow dung @ 20t ha^{-1}) on growth behavior of coriander. There were 9 treatments with 3 replications. Combined inoculation of biofertilizers along with vermicompost and NPK (T_6) showed superiority with respect to plant height both at 45 DAS (40.80cm) and at maturity (63.96 cm), number of primary (7.42) and secondary branches (13.07), stem girth (3.37cm), root length (14.39cm) followed by T_3 treatment (Azospirillum + Vermicompost + NPK) where the plant height, number of primary and secondary branches, stem girth and root length were 63.09cm, 7.35, 12.22, 3.27cm and 14.05cm respectively. Treatment T_6 also exhibited earliness for 50% flowering (61.66) and seed setting (79.49), days for fruit setting (96.79) and maturity (103.96). Seed yield was also obtained higher with T_6 (13.34 tha^{-1}) followed by T_3 (13.06 tha^{-1}), and was obtained lowest (6.19 tha^{-1}) when plants were raised with cow dung manure. The use of bio-fertilizers is therefore recommended as an approach to integrated nutrient management for better yield in coriander and sustenance of soil health.

INTRODUCTION

Coriandrum sativum L. is quite popular for its peculiar sweet fragrance in leaves and fruits and is recognized well as good source of vitamins and minerals. Use of biofertilizers increases the soil potency. Low cost and safety for the environment therefore make bio-fertilizers advantageous as an alternative to mineral fertilizers. Industrial agriculture has caused serious deterioration of soil health due to indiscriminate use of fertilizers etc and has resulted environmental pollution. Application of biofertilizers provides effective implementation of biological mechanism of plant nutrition, growth promotion and protection (Bashan *et al*., 1995). These are important arguments for the use of biofertilizers as prospective elements for nutrient management in organic agriculture.

The present investigation was under taken to determine the influence of different biofertilizers like Azospirillum, Azotobacter, PSB (*Bacillus polymyxa* and *Pseudomonas striata*) and K-mobilizers in combination with organics and inorganics on the growth, flowering, fruit setting, maturity and yield of coriander and also to assess the amount of biofertilizers for beneficial exploitation on maximum response in coriander in the New Alluvial zone of West Bengal.

MATERIALS AND METHODS

The experiment was carried out in 2008-09 and 2009-10 during the months of November to March to evaluate the influence of biofertilizers on coriander at Mondouri Teaching Farm of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India. The site of the experiment is situated at 23.5°N latitude and 89° E longitude with an average altitude of 9.75m above mean sea level. The soil of the experimental site is typical Gangetic alluvial soil (Entisol) having sandy loam texture, well drained with medium fertility status. The site where the experiment was carried out is under subtropical humid climate as it is situated just south of the Tropic of Cancer. The season of this region are broadly classified as Dry and Warm (March to May), Wet and Warm (June to October), Dry and Cool (November to February). In summer, temperature is high but the winter is short and mild. The crop was grown during the winter season. There were 3 replications of each of the 9 treatments viz., T_1- PSB (*Bacillus polymyxa*) + Vermicompost + NPK, T_2- Azotobacter (*A. chroococum*) + Vermicompost + NPK, T_3- Azospirillum (*A. lipoferum*) + Vermicompost + NPK, T_4- K-mobilizer (*Fraturia aurantia*) + Vermicompost + NPK, T_5- PSB (*Pseudomonas striata*) + Vermicompost + NPK, T_6- PSB (*Bacillus polymyxa* + *Pseudomonas striata*) + Azotobacter + Azospirillum + K-mobilizer + Vermicompost + NPK, T_7- Vermicompost + NPK, T_8- Vermicompost and T_9- Cow dung manure. In all the field plots except the treatments T_8 and T_9, inorganic fertilizers N, P_2O_5 and K_2O @ 30:30:15 kg ha^{-1} was applied through urea, single super phosphate and muriate of potash. Vermicompost @ 2t ha^{-1} and plots with treatment T_9 were applied with cowdung manure @ 20t ha^{-1}. The observations on growth characters and yield were recorded.

Table 1: Influence of organics, bio-fertilizers and inorganics on plant height at 45 days after sowing and at time of maturity and number of primary and secondary branches per plant, stem girth and root length of coriander

Treatments	Plant Height 45 DAS (cm)	Plant Height at maturity (cm)	Primary branches / plant	Secondary branches/ plant	Stem girth (cm)	Root length (cm)
T_1	36.93	59.72	6.58	8.91	3.07	12.89
T_2	38.90	61.27	6.57	10.17	3.13	13.14
T_3	40.41	63.09	7.35	12.22	3.27	14.05
T_4	36.64	59.33	6.30	8.80	3.00	12.36
T_5	38.36	60.97	6.45	8.85	3.12	12.97
T_6	40.80	63.96	7.42	13.07	3.37	14.39
T_7	35.97	58.03	6.20	7.72	2.96	12.05
T_8	35.70	55.53	6.00	7.24	2.77	11.61
T_9	34.70	51.23	5.67	6.55	2.56	11.19
SEm±	0.880	0.982	0.08	0.18	0.11	0.38
C.D. at 5%	2.638	2.946	0.26	0.77	0.33	0.16

Table 2: Influence of organics, bio-fertilizers and inorganics on days for 50% flowering, 50% seed setting, fruit setting and complete maturity of coriander

Treatments	Days for 50% flowering	Days for 50% seed setting	Days for fruit setting	Days for complete maturity	Seed yield (q ha^{-1})
T_1	63.89	81.91	101.27	106.00	9.92
T_2	62.58	81.69	97.42	104.71	11.80
T_3	62.30	79.68	97.18	104.28	13.06
T_4	64.61	83.25	101.61	107.95	8.53
T_5	63.59	82.96	101.64	106.46	10.55
T_6	61.66	79.49	96.79	103.96	13.34
T_7	65.33	83.26	102.00	108.99	7.80
T_8	65.16	83.71	102.57	109.65	6.84
T_9	66.37	83.62	104.27	111.76	6.19
SEm±	0.71	0.48	0.68	0.49	0.33
C.D. at 5%	0.13	1.45	1.90	1.48	0.94

The data collected from the field on vegetative growth characters {plant height at 45 DAS and at maturity (cm), number of primary and secondary branches, stem girth (cm), root length (cm)}, days for 50% flowering, 50% seed maturity, fruit setting, complete maturity and yield (tha^{-1}) were subjected to statistical analysis after pooled of 2 years to the randomized block design by following procedure laid out by Gomez and Gomez (1984). For determination of standard error of mean (S. Em. ±) and the value of critical difference (C. D) between the treatment means as 5% level of significance the statistical table formulated by Fisher and Yates (1979) was referred.

RESULTS AND DISCUSSION

Growth parameters

In the present investigation, the highest plant height at 45 days after sowing (40.80cm) and at time of maturity (63.96cm) were recorded with combined application of bio-fertilizers + NPK + vermicompost and lowest (34.70cm and 51.23cm respectively) in only cow dung manures treated plants. The greater increase in plant height and spread may be due to the build-up of colonies of the applied bio - fertilizers inoculates and their growth promoting substances as mentioned by Tien *et al*., 1979 with Pearl millet. Azospirillum and phosphobacteria association independently or in combination enhances the available N and P status respectively, which can assist the host plant to promote growth (Gaur, 1990) this may be because of better nitrogen fixation due to accelerated bacterial activity with better root system which might have resulted in more nitrogen accumulation. Abou-Aly and Gomaa (2002) reported significant increase in vegetative growth in coriander with dual inoculation of coriander seeds with non-symbiotic N2-fixers and phosphate solubilizers with half dose of N fertilizer. Similar to the present investigation, Kalidasu *et al*. (2008) also reported better plant height, number of primary and secondary branches with 100%N in combination with Azospirillum, PSB and FYM.

Significant variation was noticed among primary and secondary branches per plant due to the interference of different bio-fertilizers along with RDF and vermicompost in the present investigation. The combination of bio-fertilizers (PSB, Azotobacter, Azospirillum and KM) along with Vermicompost and NPK produced highest number of primary branches (7.42) and secondary branches (13.07) respectively (Table 1). Even single inoculation of each bio-fertilizer along with vermicompost and NPK showed significantly greater number of branches per plant. Azospirillum among the single inoculation of bio-fertilizer recorded maximum number of primary (7.35) and secondary branches (12.22) respectively (Table 1). The increased number of branches might be due to increased number of vegetative buds produced by taller plants. Similar to the present findings, Malhotra *et al*. (2006) reported that *Azospirillum sp*. inoculation along with nitrogen and farmyard manure increased the number of branches per plant on coriander. Similar observations have been reported by Shaalan, 2005 on black cumin and Choudhary *et al*., 2006 on cumin.

As the biofertilizers like Azospirillum and Azotobacter, which are the free living N_2-fixing bacteria living in the rhizoplane and rhizospheric zone have the ability to synthesize root

growth substances (Chen *et al.,* 2006) which have the positive influence on root growth and development and might caused greater root length. Root length (14.39cm) was recorded highest with combined application of bio-fertilizers consisting of Azospirillum, Azotobacter, PSB and KM along with vermicompost and NPK (Table 1). Such increase in the root length of the crop due to combined inoculation of biofertilizers were reported by Prabu *et al*., (2002) on coriander.

Flowering, fruiting, maturity and Seed yield

Use of bio-fertilizers significantly promoted early flowering, fruit setting and seed maturity as compared to uninoculated plants (only NPK, vermicompost and cow dung manures). With combined inoculation of biofertilizers consisting of Azospirillum, Azotobacter, PSB and KM along with vermicompost and NPK, had greater influence on early 50% flowering (61.66 days), 50% fruit setting (79.49 days), seed setting (96.79 days) and complete maturity (103.96 days) (Table 2). The reason for earliness in flowering, seed setting and maturity might be due to the fact that the plant treated with bio-fertilizers become physiologically more active and enable to synthesize required amount of hormones or to build up adequate food reserves. Combined inoculation of biofertilizers along with vermicompost and inorganic fertilizers (T_6) proved most effective in producing highest seed yield (13.34 q ha^{-1}) followed by T_3, T_2, T_5, T_1, T_4, T_7, T_8 and T_9 (Table 2).

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